REMARKS

Claims 1-37 are pending in the application. Claims 1, 11, 21, 22, 27, 32 and 35-37 are the base claims. Claims 35-37 have been indicated as allowed.

Claims 1-8, 10-18 and 20-34 have been rejected under 35 U.S.C. § 103 as being unpatentable over Poggio et al. (U.S. Patent No. 5,642,431) in view of Kung et al. (U.S. Patent No. 5,850,470).

By way of background in the art of image recognition, "object" and "feature" are terms of art. Given an input image, there is a subject object to be detected within the image. On the subject object are one or more features which form or compose the object.

The cited reference to Poggio et al. (col. 3, lines 52-56) only indicate that at the window located at the stated position and scale, the system "...attempts to classify the enclosed image pattern as being either a face or not a face." Whereas Poggio et al. disclose the technique of applying a general detection algorithm at a specific location and scale, it does not address the specific claim of applying a cascade of homogeneous classification functions for the purpose of object detection. The present invention as claimed is not intended to address the general case, but rather the specific case as stated in the foregoing amended claims.

In Kung et al., the object being detected is a face in an input image. The eyes are one of many features of the face. See col. 1, lines 34-40. Thus it is an object of Kung et al. to "...provide a decision-based neural network and system for implementing the network that locates and recognizes the deformable objects with specific applications directed at detecting human faces and locating eyes in the faces." See column 2, lines 50-54.

In Fig. 1, Kung et al. employs a face classifier 14 in series with an eye classifier 18. Fig. 5 of Kung illustrates a multi-sensor, multi-channel embodiment and does not employ a cascade/series of classifiers. Instead each channel works in parallel and each channel works on a respective feature (see col. 11, lines 21-30). Both Fig. 5 and the reference to "lateral fusion of information" indicate that the outputs of the channel classifiers are to be combined in some way before a decision is made to accept or reject the input window under consideration. Further, these channel classifiers are not homogeneous. The reference in col. 11, lines 26-27 indicates that the channel classifiers receive "input vectors either from different sensors or from a portion of a higher dimensional feature vector", the implication being that the input is different and therefore that the function for each channel is different. Fig. 5 also clearly indicates that channels

1 and 2 receive different input. Furthermore, the output classifier 60 is clearly different in both input and output to the channel classifiers.

In contrast, the present invention as now claimed provides a cascade of classifiers each represented by a respective homogeneous classification function. Each homogeneous classification function (i.e., classifier) covers a same plurality of features. In cascade/series order, a preceding classifier identifies the plural features at one level of accuracy and a subsequent classifier identifies the same plural features at an increased level of accuracy with respect to the preceding classifier. Such a series of classifiers ("homogeneous classification functions in sequence in the cascade respectively having increased accuracy in identifying the same features associated with the certain objects") as claimed in base Claims 1, 11, 21 and similarly in Claims 22, 27 and 32, is not implied, suggested or otherwise made obvious by the cited art. Support for this claim language is found at least on Specification page 4, lines 1-13 as originally filed. No new matter is introduced.

Further, none of the cited references, especially Kung et al., disclose a homogeneous classification function covering a plurality of features, and a respective such homogeneous classification function at each position in the series/cascade covering the same plurality of features. Kung's classification functions cover only one feature or one subject area at a time (for example, eye classifier 18 and the face detector 14). That is, the classification function of face detector 14 and the classification function of eye classifier 18 are not analogous to a first classifier in cascade/series order with a succeeding classifier of the present invention. The classification function of the eye classifier 18 in Kung et al. does not identify the same plural features as the face detector 14 in Kung et al. in contrast to the present invention as now claimed.

Restated, the claimed present invention classification functions are homogeneous in both functional form and in functional purpose. That is, the functions accept identical inputs which are processed by a functional form from a same class of functions, and return a classification into identical classes. Each of the classifiers in the present invention cascade fits this description, and it is the unique contribution to this work.

The cited classifiers in Kung et al. perhaps have homogeneous functional form (DBNN as pointed out by the Examiner), but they do not have homogeneous functional purpose where the returned values (face or no face for detector 14 and eye locations for classifier 18 differ). Furthermore, Kung discloses (col. 4, lines 28-30) that "...the pattern resolution used for the eyes is substantially higher than that used for the faces". This indicates that the inputs to the eye

classifier 18 differ from those of the face detector 14 and indeed that there may be some processing (e.g., rescan of the image at higher resolution) required between face detection and eye locating. The critical point in the present invention is that the cascades function by taking a single input pattern and presenting it unchanged to each of a series of classification functions one after the other. Each of those classification functions are drawn from the same classification functions (homogeneous functional form) and return classification into the same two classes (homogeneous functional purpose).

The Examiner further disagrees with the claimed feature that the present invention is particularly enabling for real time applications. It is true that the inclusion of "real time application" is somewhat confusing because Kung et al. does disclose the possibility of tailoring hardware to achieve real time performance. See col. 12, lines 54-57. However, Applicants' claim for a "quick" system is based on a few key elements:

1. The usage of simple geometric features. See Specification page 3, lines 21-30.

2. The usage of an integral image so that the number of operations per patch (subwindow) is independent of the patch dimensions. See Specification page 3, lines 15-20.

3. The usage of a cascade as described above which quickly rejects a large portion of the candidate patches while propagating only a small number of candidates for final verification. See Specification page 4, lines 1-15.

It is the combination of these elements that provides a "quick" system in the present invention. This is now claimed in terms of "...said employing including discarding subwindows that insufficiently show features of the certain objects and continuing to process through the cascade only subwindows having sufficient features that indicate a likelihood of an instance of the certain objects in the subwindows." See base Claims 1, 11, 21, 22, 27 and 32 as now amended.

Accordingly, none of the cited references or prior art provide the new limitations of the base claims as now amended to further highlight the present invention. The pertinent terms are:

> "...a cascade of homogeneous classifiers each represented by a respective homogeneous classification function covering a same plurality of features,..."
>
> "...such that one classifier identifies the plural features at one level of accuracy and a subsequent classifier in the cascade sequence identifies the same plural features at an increased level of accuracy with respect to the one classifier..."and

"...including discarding subwindows that insufficiently show features of the certain objects and continuing to process through the cascade only subwindows having sufficient features that indicate a likelihood of an instance of the subject objects in the subwindows."

These claim terms or the equivalent are recited in now amended base Claims 1, 11, 21-22, 27 and 32. Dependent Claims 2-8, 10 and 33 inherit the same claim terms from base Claim 1. Dependent Claims 12-18, 20 and 34 inherit the claim limitations from base Claim 11. Dependent Claims 23-26 follow base claim 11. Dependent Claims 28-31 follow base Claim 27. As such, the rejection under § 103 is believed to be overcome. Withdrawal of this rejection with respect to Claims 1-8, 10-18 and 20-34 is respectfully requested.

Claims 9 and 19 are indicated as being objected to. Claim 35 newly presented in the previous amendment rewrites Claim 9 in independent form. Similarly, Claim 36 newly presented in the previous amendment rewrites dependent Claim 19 in independent form. Claims 35-37 are indicated as allowed. Accordingly, all claims are believed to be in allowable condition and such allowance is respectfully requested.

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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